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GB 2265744 A WO 94/04941 A1 WO 90/13103 A1
WO 87/05138 A1 US 4694295 A

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(54) Radar for vehicle's blind spots

(57) A vehicle is equipped with a Doppler microwave FMCW radar which points backwards and sideways towards the vehicle's blind spots. The modulation is at a ultrasonic frequency. If any other vehicle persistently within a suitable speed range is detected (eg whilst overtaking) a visual warning is given. If the equipped vehicle is turning (determined by sensing the steering wheel position or actuation of indicators) into the path of the overtaking vehicle, a further audible warning is also given.

The transmitter/receiver and amplifier are be mounted on the rear-view mirror, with the rest of the processing being within the vehicle's body.

A reversing aid is a modification, actuated by selection of reverse gear.

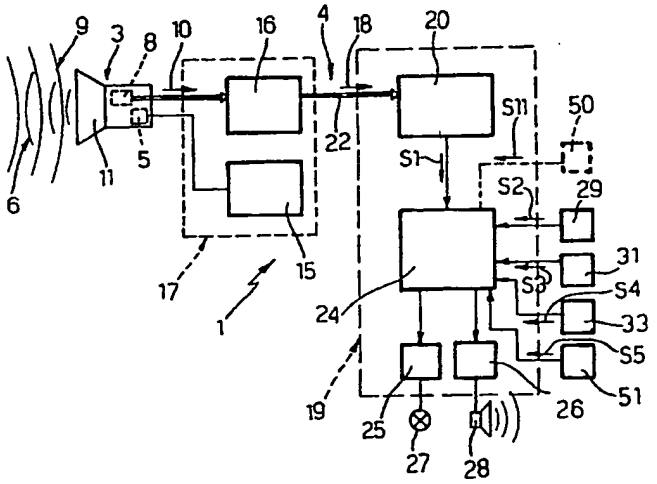

Fig. 1

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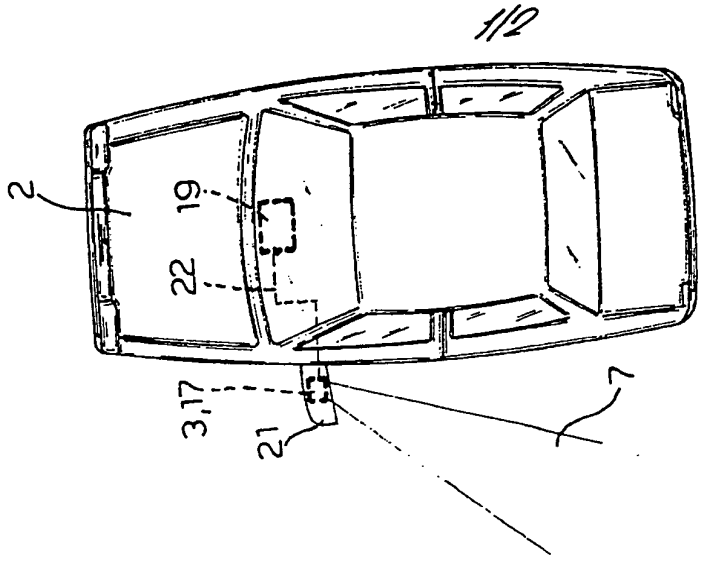
1/2
2
19
22
3,17
21
7

Fig.2

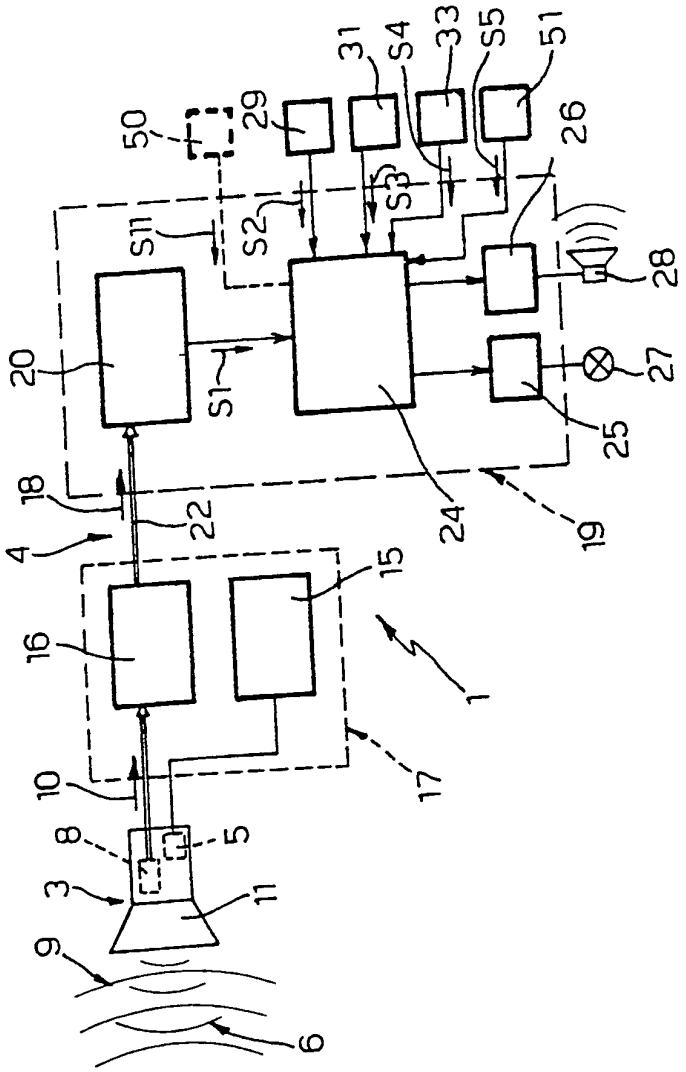
31
S4
33
S5
51
50
29
26
S3
S11
S2
28
20
S1
27
25
18
22
24
19
4
15
16
1
10
17
8
5
3
11
9
6

Fig. 1

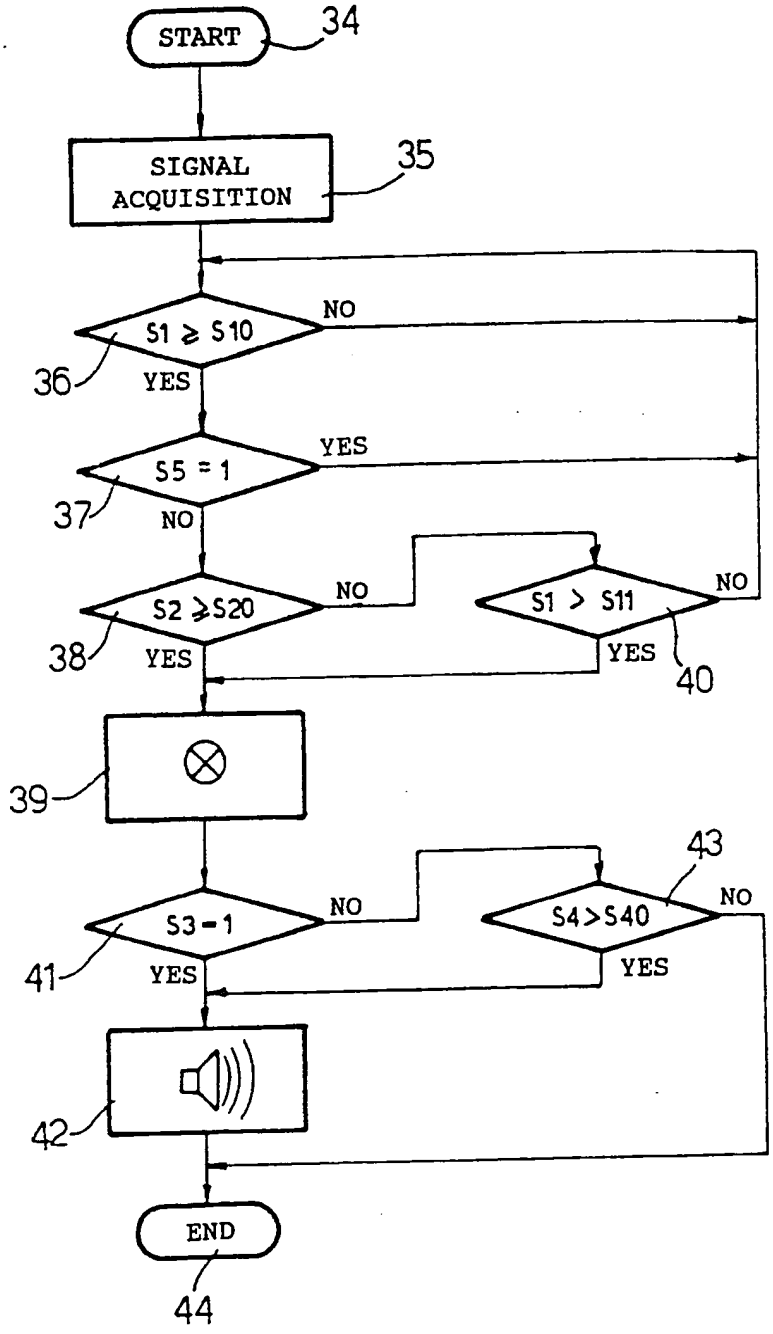
START
34
SIGNAL ACQUISITION
35
S1 ≥ S10
NO
36
YES
S5 = 1
YES
37
NO
S2 ≥ S20
NO
S1 > S11
NO
38
YES
YES
40
39
43
S3 = 1
NO
S4 > S40
NO
41
YES
YES
42
END
44

Fig. 3

SAFETY DEVICE FOR A VEHICLE CAPABLE OF DETECTING THE PRESENCE OF BODIES IN RELATIVE MOTION IN A REGION WHICH CANNOT BE VISUALLY OBSERVED BY A DRIVER

The present invention relates to a safety device capable of being installed on a vehicle for detecting the presence of bodies in relative motion in a region of space which cannot be visually observed by the driver, and in particular the presence of other vehicles in an overtaking phase.

Safety devices are known which comprise an electromagnetic sensor accommodated in a rear-view mirror of the vehicle and capable of emitting a beam of microwaves directed towards a lateral region to the rear of the vehicle, advantageously towards the so-called blind spot of that mirror. The sensor is also capable of generating electrical signals in response to the waves reflected by another vehicle present in that region. The device furthermore comprises a circuit for processing the said electrical signals capable of recognising a condition of approach of the other vehicle and of actuating, in that situation, an alarm signal. Advantageously, the actuation of the alarm signal is inhibited when the vehicle is reversing and when the relative speed of the vehicle which is overtaking is below a threshold value which can be preset or vary with the speed of the vehicle on which the device is installed.

A device of the type briefly described is illustrated by Italian Patent Application No. 68043-A/88.

This device is not, however, without disadvantages. In

particular, the alarm signal is actuated whenever the vehicle is overtaken by another vehicle, which happens fairly frequently under normal driving conditions and does not in itself constitute a condition of risk of collision. The driver may thus be annoyed by the frequent alarm signals and be led to ignore these signals or even, if it is possible, to switch off the device, thus also disregarding the signals when there is actual danger.

The purpose of the present invention is to make a device which does not have the above-mentioned disadvantage and is therefore capable of generating an alarm signal only when there is a real danger of collision.

The above-mentioned purpose is achieved by the present invention in that the latter relates to a safety device capable of being installed in a vehicle to detect the presence of bodies in relative motion in a region of space which cannot be visually observed by a driver, of the type comprising an electromagnetic sensor capable of emitting a beam of electromagnetic waves towards the said region and of generating electrical signals in response to a beam of waves reflected by a body present in the said region, at least a first warning device capable of being disposed in an interior compartment of the said vehicle and an electronic circuit for processing the said generated electrical signals comprising means capable of generating a first signal indicating the relative speed of the said body in relation to the said vehicle and means capable of actuating the said first warning device in response to a value of the said first signal corresponding to a condition of approach of the said body, characterised in that the said the means capable of actuating the first warning device comprises means for detecting signals indicating a change in direction of the

said vehicle and means for actuating the said first warning device in response to the said signals.

A further disadvantage connected with the known devices is constituted by the fact that, in order to obtain a high signal-to-noise ratio at the input of the processing circuit, the latter must be connected to the sensor by cables which are as short as possible; consequently this circuit is normally accommodated close to the mirror, a fact which creates considerable problems with regard to mounting, space occupied and sealing. This disadvantage could be at least partly overcome by the use of screened cables, but these are expensive.

According to a preferred form of embodiment of the present invention, this disadvantage is overcome by the fact that the electronic circuit is sub-divided into a first circuit group comprising at least an amplification block for amplifying the signals generated by the sensor and into a second circuit group comprising at least the means capable of actuating the first warning device. When the safety device is in a vehicle provided with an external rear-view mirror the sensor and the first circuit group are preferably accommodated in the said rear-view mirror and the second circuit group is preferably accommodated within the vehicle, in the most convenient position. In this way the signal is amplified up-circuit of the noise introduced by the cables, and the signal-to-noise ratio is high even if relatively long and unscreened cables are used.

To enable the present invention to be better understood, a description will now be given of a preferred embodiment, as a non-limitative example and with reference to the accompanying drawings, in which:

Figure 1 shows a functional layout of a safety device made in accordance with the requirements of the present invention;

Figure 2 illustrates an example of installation of the device shown in Figure 1 in a motor vehicle; and

Figure 3 is a diagram showing the functions performed by a processing block of the device shown in Figure 1.

With reference to Fig. 1, there is indicated as a whole by 1 a safety device capable of being installed in a vehicle 2, partly shown in Fig. 2, for detecting the presence of other vehicles in the overtaking phase.

The device 1 essentially comprises a Doppler-effect electromagnetic sensor 3 and a circuit 4 for supplying power to the sensor 3 and processing the signals generated by it.

The sensor 3 consists of a microwave generator 5 capable of emitting a beam of microwaves 6 towards a region of space 7 situated at the side and to the rear of the vehicle and of microwave-detecting means 8 capable of detecting a wavebeam 9 reflected by a body, for instance another vehicle, situated in the said region of space and of generating electrical signals 10 in the presence of such reflected waves. The generator 5 and the detecting means 8 are advantageously accommodated in a hollow element 11 having the function of waveguide and aerial.

The sensor 3 will not be described in greater detail because it is known, for example, from Italian Patent Application No. 68043-A/88, the contents of which are deemed to be incorporated herein for reference and for

the necessary parts. The circuit 4 essentially comprises a supply regulator block 15 connected to the generator 5 and capable of supplying the latter with a supply voltage presenting a slight ultrasonic frequency modulation, as described in the patent application cited above. The circuit 4 furthermore comprises an amplification block 16 for amplifying the signals 10, connected to the output of the detecting means 8.

The block 15 and the block 16 together constitute a first circuit group 17 capable of generating at its output amplified signals 18 indicating the presence of a vehicle in the region of space 7 towards which the sensor 3 is facing.

The sensor 3 and the first circuit group 17 are advantageously accommodated within an external rear-view mirror 21 of the vehicle 2 (Fig. 2); the region of space 7 monitored by the sensor 3 advantageously includes the so-called blind spot of the mirror 2.

The circuit 4 furthermore comprises a second circuit group 19 receiving at its input the above-mentioned signals 18, which is connected to the first circuit block 17 by means of electrical cables 22.

The second circuit group 19 essentially comprises a discriminator block 20, which is also known per se and is therefore not described in detail, which is capable of generating an output signal S1 in response to the input signals 18; in particular, the signal S1 is correlated to the frequency shift f ("Doppler shift") of the reflected waves 9 from the other vehicle in relation to the emitted waves 6. This shift occurs, as is known, when the other vehicle is in relative motion in relation to the vehicle

2, and is positive if the other vehicle is approaching and negative in the opposite case.

The second circuit group 19 comprises, lastly, a microprocessor processing block 24 to the outputs of which there are connected, via respective relays 25, 26, an illuminated warning device 27, for example a pilot lamp disposed on the instrument panel of the vehicle, and an audible warning device 28 disposed in the interior compartment of the vehicle.

The block 24 is furthermore connected to a tachometer sensor 29, from which it receives a signal S2 correlated to the speed of the vehicle, and for example proportional to it.

According to the present invention, the block 24 furthermore receives an input signal S3 from a change-of-direction indicating group 31 of the vehicle when a direction indicator is actuated on the same side as the mirror 2 in which the sensor 3 is mounted, and a further input signal S4 from a sensor 33 capable of detecting an actual change in direction of the vehicle. This sensor 33 may be, for instance, an angular-position transducer associated with the steering wheel or a linear transducer associated with a moving part of the steering-column assembly.

The block 24 is connected, lastly, to a reverse-gear-engagement sensor 51, from which it receives a signal S5.

The operation of the sensor 3, the first circuit block 17 and the discriminator block 20 is known and will therefore not be described in detail.

The operation of the block 24 will now be described with reference to the flow chart shown in Fig. 3.

From a cycle-start block 34 the process moves on to a block 35 for the acquisition of the input signals S1, S2, S3, S4 and S5.

It then goes on to a block 36 in which a check is made to determine whether the value of S1 is at least equal to a threshold value S10 corresponding to a positive Doppler shift f (vehicle approaching in region 7) which is very small, for example indicating a relative speed of approach of 2 km/h. If this is not so, the process returns to the start of the cycle. If this is so, the process moves on to a block 37 in which it is checked whether signal S5 is active. If so, i.e. if reverse gear is engaged, the process returns to the start of the cycle. If this is not so, the process moves to a block 38 in which signal S2 is compared with a threshold value S20 corresponding to a low speed of the vehicle, for instance 10 km/h. If S2 is greater than or equal to S20 the process moves on to a block 39, in which the relay 25 of the warning light 27 is actuated. If S2 is lower than S20 the process moves to a block 40 in which it is checked whether the value of S1 is greater than a threshold value S11 corresponding to a relative speed of, for instance, 20 km/h. If this continues to be so, the process moves on again to block 39; if not, it returns to the start of the cycle.

From block 39 the process moves on to a block 41, in which it is checked whether signal S3 is active. If so, it moves on to a block 42 which actuates the relay 26 of the audible warning device 28, and thus to the end of the cycle (block 44). If not, the process moves to a block 43

in which it is checked whether signal S4 is greater than a threshold value S40 corresponding to a condition of slight steering towards the side of the mirror 2. If this condition is found to exist, the process moves on further to block 42; if not, it moves to an end-of-cycle block 44.

It will be seen from the foregoing that the device 1 verifies, in short, the presence of bodies approaching the region 7 of action of the sensor 3 and in that case actuates the visual warning device 27. This happens only when the vehicle is stationary or travelling forward, but not when reverse gear is engaged; this prevents the emission of unjustified signals, for instance if the vehicle is reversing towards other, parked vehicles. Moreover, the device 1 discriminates between the condition when the vehicle is stationary, or almost so, and the condition when it is travelling normally ($S2 \geq S20$). In the former case the visual alarm is actuated even at very low relative speeds; in the latter case the signal is actuated only when the relative speed exceeds a threshold value ($S1 > S11$), so as to avoid unwanted signals in certain operational situations. Think, for example, of a tailback situation with parallel queues, where the vehicles slowly overtaking in an adjacent lane could unjustifiably actuate an alarm signal.

According to the present invention, the device 1 also actuates an audible warning device, but only when the driver signals his intention to change the direction of motion or steering, thus creating a real risk of collision with the overtaking vehicles.

In this way, merely potential risk situations, created by overtaking by another vehicle in the blind corner of the

rearview mirror, are signalled only visually; the driver is therefore not disturbed or annoyed by frequent but not very meaningful audible signals; nevertheless he has at his disposal a useful visual instrument, in addition to the rear-view mirrors, for assessing the relative movement of the other vehicles.

If, on the other hand, the driver turns the steering wheel or signals his intention to do so, he is audibly warned of the real risk of collision, and thus the dangerous manoeuvre is effectively prevented.

The described positioning of the device 1, in which the sensor 3 and the first circuit group 17 are accommodated in the mirror 21, is particularly advantageous in that the signals 18 at the output of the group 17 are amplified, and therefore the signal-to-noise ratio at the input to group 19 is high even if the cables are relatively long; the group 19 can therefore be accommodated in any convenient position in the vehicle, for example in the instrument panel.

Lastly, it is clear that modifications and variants which do not go beyond the scope of the protection afforded by the present invention can be made to the device 1 which has been described. In particular, the visual warning device can be eliminated, or it, too, can be actuated only in the situation of real risk described above. Furthermore, means can be provided for manual regulation of the threshold value S11, for example a potentiometer 50 indicated by dotted lines in Fig. 1, accommodated in the interior compartment and able to be regulated manually by the driver depending on traffic conditions.

CLAIMS:

1. A safety device capable of being installed in a vehicle for detecting the presence of bodies in relative motion in a region of space which cannot be visually observed by a driver, of the type comprising an electromagnetic sensor capable of emitting a beam of electromagnetic waves towards the said region and of generating electrical signals in response to a beam of waves reflected by a body present in the said region, at least a first warning device capable of being disposed in an interior compartment of the said vehicle, and an electronic processing circuit for processing the said generated electrical signals comprising means capable of generating a first signal indicating the relative speed of the said body in relation to the said vehicle and means capable of actuating the said first warning device in response to a value of the said first signal corresponding to a condition of approach of the said body, characterised in that the said means capable of actuating the said first warning device comprises detecting means for detecting signals indicating a change of direction of the said vehicle and actuating means for actuating the said first warning device in response to the said signals.

2. A device as claimed in Claim 1, characterised in that the said detecting means comprises first detecting means for detecting a signal indicating the actuation of a direction indicator of the said vehicle.

3. A device as claimed in Claim 1 or 2, characterised in that the said detecting means comprises second detecting means for detecting a signal indicating the position of an element of a steering device of the said

vehicle.

4. A device as claimed according to any one of the preceding claims, characterised in that the said first warning device is of an audible type.

5. A device as claimed in any one of the preceding claims, characterised in comprising a second warning device of an illuminable type.

6. A device as claimed in Claim 5, characterised in that the said means capable of actuating the said first warning device additionally comprises actuating means for actuating the said second warning device in response to the said first signal and independently of the said signals indicating a change of direction of the said vehicle.

7. A device as claimed in Claim 5 or 6, characterised in that the said means capable of actuating said first warning device comprises detecting means for detecting a tachometer signal and first enabling means which can control the actuation of the said first and second warning devices, the first enabling means allowing actuation of the first and second warning devices in the presence of a value of the said tachometer signal greater than a threshold value.

8. A device as claimed in Claim 7, characterised in that the said processing means capable of actuating the first warning device comprises second enabling means which can control the actuation of the said first and second warning devices, the second enabling means allowing actuation of the said first and second warning devices in the presence of a value of the said tachometer

signal which is lower than the said threshold value and of a value of the said first signal which is greater than a respective threshold value.

9. A device as claimed in Claim 8, characterised in that it comprises means for the manual regulation of the said threshold value of the said first signal.

10. A device as claimed in any one of the preceding claims, characterised in that the said electronic circuit is sub-divided into a first circuit group comprising at least amplifying means for amplifying the said signals generated by the said sensor and into a second circuit group comprising at least the said means capable of actuating the first warning device.

11. An arrangement for a safety device as claimed in Claim 10 in a vehicle provided with an external rear-view mirror, characterised in that the said sensor and the said first circuit group are accommodated in the said rear-view mirror and that the said second circuit group is accommodated within the said vehicle.

12. A vehicle provided with an external rear-view mirror and with a safety device as claimed in Claim 10, characterised in that the said sensor and the said first circuit group are accommodated in the said rear-view mirror and that the said second circuit group is accommodated within the said vehicle.

13. A rear-view mirror for a vehicle provided with a safety device as claimed in Claim 10, characterised in that it comprises the said sensor and the said first circuit group.

14. A safety device capable of being installed on a vehicle for detecting the presence of bodies in relative motion in a region of space which cannot be visually observed by a driver, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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r 'ents Act 1977 L .aminer's report to the Comptroller under Section 17 (The Search report)	Application number GB 9422555.4
Relevant Technical Fields (i) UK Cl (Ed.N) H4D (DRPC, DLAB, DLAA, DLRA, DLRC, DLVD, DLVX, DLRE, DLRG, DAA, DAB); G4N (NHVSC); G4Q (QCE) (ii) Int Cl (Ed.6) G01S, G08G	Search Examiner Dr E PLUMMER Date of completion of Search 30 JANUARY 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI, EDOC	Documents considered relevant following a search in respect of Claims :- ALL

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Y:	Document indicating lack of inventive step if combined with one or more other documents of the same category.	E:	Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A:	Document indicating technological background and/or state of the art.	&:	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2265744 A	(JONES) whole document	1, 3 to 6, 10
P, X	WO 94/04941 A1	(VORAD SAFETY SYSTEMS) note Figure 1, abstract, page 14 lines 1 to 21	1 to 6, 10
X	WO 90/13103 A1	(AUTOSENSE) note abstract	1, 2, 5, 10 to 13
X	WO 87/05138 A1	(BEGGS & SPECK) whole document	1 to 7, 10
X	US 4694295	(MILLER ET AL) note column 9 lines 15 to 21	1, 2, 4, 5, 6 to 10

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